

Table 10
Summary of Revised Remedial Cost Estimates for CMS Selected Alternative by Yard
Chevron Perth Amboy Refinery
Perth Amboy, New Jersey

CMS Selected Alternative	Yard	Total Cost
a) SWMU 43 Hazardous Soil - Hot Spot ISCO Treatment for organic contaminants and In-situ Stabilization for lead with Non-RCRA Cap	Main	\$14,717,312
b) Non-SWMU 43 Hazardous Soil – ISCO Treatment for organic contaminants and Excavation, Stabilization and Disposal in Tailored CAMU for TCLP lead levels >5mg/L	East	\$9,277,986
c) Non-Hazardous Soil – ISCO Treatment for organic contaminants and In-Situ Stabilization for lead levels >800 mg/kg and TCLP lead levels <5 mg/L	Central	\$783,227
d) Arsenic Impacted Soil - Capping of Arsenic Soil Contamination		
e) Benzo(a)pyrene >10 mg/kg Impacted Soil - Excavation, Stabilization and Disposal in Tailored CAMU for benzo(a)pyrene concentrations >10 mg/kg	All Yards	\$8,182,687
f) Groundwater – ISCO Treatment for benzene concentrations > 100 ug/L and MNA for benzene concentrations ≤ 100 ug/L		
g) LNAPL - LNAPL Removal Measures	Total	\$32,961,212

Notes:

1. CAMU = Corrective Action Management Unit
2. Tailored CAMU involves the sizing of a CAMU to the amount of hazardous soil and NAPL-contaminated media previously planned to be sent off-site for treatment and disposal in a Subtitle C and Subtitle D landfill, respectively.
3. LNAPL removal measures (LRMs) include the use of a vac truck and skimmer belts.

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			Volume (yd ³)	Weight (tons)	Unit Cost	Total Cost
M A I N Y A R D	All Contaminated Media	Additional Pre-Design Investigation	NA	NA	NA	NA
	SWMU 43 Hazardous Soil	Surveying	61,974 ft ²	NA	NA	\$13,630
		Engineering Design, Oversight, and Reporting	NA	NA	NA	\$342,424
		Removal of Concrete Pad	38,500 ft ²	NA	\$0.94/ft ²	\$36,190
		Hot Spot ISCO Treatment	1,622	2,432	\$60/ton	\$145,935
		In-Situ Stabilization Treatment	49,749	74,624	\$35/ton	\$2,611,823
		Restoration	62,186	93,279	\$4.41/yd ³	\$274,241
		Subtotal				\$3,424,243
	Non-SWMU 43 Hazardous Soil	Surveying	40,905 ft ²	NA	NA	\$9,000
		Engineering Design, Oversight, and Reporting	NA	NA	NA	\$10,579
		ISCO Treatment	1,065	NA	\$40/yd ³	\$42,600
		Excavation	300	450	\$6.06/yd ³	\$1,818
		Transportation	300	450	\$5.51/ton	\$2,480
		Stabilization Mobilization	NA	NA	NA	\$5,513
		Stabilization and Recycling as Certified Clean Fill	NA	NA	NA	NA
		Stabilization and Disposal in Tailored CAMU	300	450	\$50/ton	\$22,500
		Placement in Tailored CAMU	330	495	\$0.83/yd ³	\$274
		Backfill	375	563	\$25/yd ³	\$9,375
		Restoration	375	563	\$4.41/yd ³	\$1,654
		Subtotal				\$105,792
	Non-Hazardous Soil	Surveying	28,395 ft ²	NA	NA	\$6,250
		Engineering Design, Oversight, and Reporting	NA	NA	NA	\$238,896
		ISCO Treatment	33,333	50,000	\$40/yd ³	\$1,333,320
		In-Situ Stabilization Treatment	13,971	20,957	\$35/ton	\$733,478
		Restoration	17,464	26,196	\$4.41/yd ³	\$77,015
		Subtotal				\$2,388,958
	Benzo(a)pyrene >10 mg/kg Impacted Soil	Surveying	59,553 ft ²	NA	NA	\$13,100
		Engineering Design, Oversight, and Reporting	NA	NA	NA	\$129,069
		Excavation	9,000	13,500	\$6.06/yd ³	\$54,540
		Transportation	9,000	13,500	\$5.51/ton	\$74,385
		Stabilization Mobilization	NA	NA	NA	\$5,513
		Stabilization and Disposal in Tailored CAMU	9,000	13,500	\$50/ton	\$675,000
		Placement in Tailored CAMU	9,900	14,850	\$0.83/yd ³	\$8,217
		Backfill	11,250	16,875	\$25/yd ³	\$281,250
		Restoration	11,250	16,875	\$4.41/yd ³	\$49,613
		Subtotal				\$1,290,686
	Groundwater	Engineering Design, Oversight, and Reporting	NA	NA	NA	\$750,763
		MNA Monitoring	670,950	NA	NA	\$1,357,650
		ISCO Treatment	134,981	NA	\$40/yd ³	\$5,399,220
		Subtotal				\$7,507,633
	MAIN YARD TOTAL COST					\$14,717,312

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			Volume (yd³)	Weight (tons)	Unit Cost	Total Cost	
E A S T Y A R D	All Contaminated Media	Additional Pre-Design Investigation	NA	NA	NA	NA	
	Hazardous Soil	Surveying	664 ft²	NA	NA	\$1,500	
		Engineering Design, Oversight, and Reporting	NA	NA	NA	\$34,159	
		ISCO Treatment	110	NA	\$40/yd³	\$4,380	
		Excavation	2,331	3,497	\$6.06/yd³	\$14,126	
		Transportation	2,331	3,497	\$5.51/ton	\$19,266	
		Stabilization Mobilization	NA	NA	NA	\$5,513	
		Stabilization and Recycling as Certified Clean Fill	NA	NA	NA	NA	
		Stabilization and Disposal in Tailored CAMU	2,331	3,497	\$50/ton	\$174,825	
		Placement in Tailored CAMU	2,564	3,846	\$0.83/yd³	\$2,128	
		Backfill	2,914	4,371	\$25/yd³	\$72,844	
		Restoration	2,914	4,371	\$4.41/yd³	\$12,850	
		Subtotal				\$341,590	
	Non-Hazardous Soil	Surveying	18,414 ft²	NA	NA	\$4,051	
		Engineering Design, Oversight, and Reporting	NA	NA	NA	\$169,960	
		ISCO Treatment	24,674	37,010	\$40/yd³	\$986,940	
		In-Situ Stabilization Treatment	9,285	13,928	\$35/ton	\$487,463	
		Restoration	11,606	17,409	\$4.41/yd³	\$51,184	
			Subtotal				\$1,699,597
	Arsenic Impacted Soil	Capping of arsenic soil contamination	62,862 yd²	NA	\$27.97/yd²	\$1,758,250	
		Subtotal				\$1,758,250	
	Benzo(a)pyrene >10 mg/kg Impacted Soil	Surveying	96,318	NA	NA	\$21,190	
		Engineering Design, Oversight, and Reporting	NA	NA	NA	\$246,875	
		Excavation	879	1,319	\$6.06/yd³	\$5,327	
		Transportation	879	1,319	\$5.51/ton	\$7,265	
		Stabilization Mobilization	NA	NA	NA	\$5,513	
		Stabilization and Disposal in Tailored CAMU	879	1,319	\$50/ton	\$65,925	
		Placement in Tailored CAMU	967	1,450	\$0.83/yd³	\$803	
		Backfill	1,099	1,648	\$25/yd³	\$27,469	
		Restoration	1,099	1,648	\$4.41/yd³	\$4,845	
		AOC 29 - Revetment, Asphalt Collection, and Operation, Maintenance, and Monitoring of Groundwater and Surface Water	NA	NA	NA	\$1,787,000	
		AOC 29 - Capping with Asphalt Pavement	10,602 yd²	NA	\$27.97/yd²	\$296,538	
			Subtotal				\$2,468,749
		Groundwater	Engineering Design, Oversight, and Reporting	NA	NA	NA	\$300,980
			MNA Monitoring	398,184	NA	NA	\$882,900
			ISCO Treatment	45,648	NA	\$40/yd³	\$1,825,920
			Subtotal				\$3,009,800
		EAST YARD TOTAL COST					\$9,277,986

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			Volume (yd ³)	Weight (tons)	Unit Cost	Total Cost
C E N T R A L Y A R D	All Contaminated Media	Additional Pre-Design Investigation	NA	NA	NA	NA
	Hazardous Soil	Surveying	233 ft ²	NA	NA	\$1,500
		Engineering Design, Oversight, and Reporting	NA	NA	NA	\$26,581
		Excavation	1,829	2,743	\$6.06/yd ³	\$11,081
		Transportation	1,829	2,743	\$5.51/ton	\$15,113
		Stabilization Mobilization	NA	NA	NA	\$5,513
		Stabilization and Recycling as Certified Clean Fill	NA	NA	NA	NA
		Stabilization and Disposal in Tailored CAMU	1,829	2,743	\$50/ton	\$137,138
		Placement in Tailored CAMU	2,011	3,017	\$0.83/yd ³	\$1,669
		Backfill	2,286	3,428	\$25/yd ³	\$57,141
		Restoration	2,286	3,428	\$4.41/yd ³	\$10,080
		Subtotal				\$265,815
	Non-Hazardous Soil	Surveying	599 ft ²	NA	NA	\$1,500
		Engineering Design, Oversight, and Reporting	NA	NA	NA	\$22,177
		ISCO Treatment	95	142	\$40/yd ³	\$3,780
		In-Situ Stabilization Treatment	3,350	5,024	\$35/ton	\$175,849
		Restoration	4,187	6,280	\$4.41/yd ³	\$18,464
		Subtotal				\$221,770
	Benzo(a)pyrene >10 mg/kg Impacted Soil	Surveying	5,760 ft ²	NA	NA	\$1,500
		Engineering Design, Oversight, and Reporting	NA	NA	NA	\$1,838
		Excavation	75	113	\$6.06/yd ³	\$455
		Transportation	75	113	\$5.51/ton	\$620
		Stabilization Mobilization	NA	NA	NA	\$5,513
		Stabilization and Disposal in Tailored CAMU	75	113	\$50/ton	\$5,625
		Placement in Tailored CAMU	83	124	\$0.83/yd ³	\$68
		Backfill	94	141	\$25/yd ³	\$2,344
		Restoration	94	141	\$4.41/yd ³	\$413
		Subtotal				\$18,376
	Groundwater	Engineering Design, Oversight, and Reporting	NA	NA	NA	\$27,727
		MNA Monitoring	186,240	NA	NA	\$158,940
		ISCO Treatment	2,265	NA	\$40/yd ³	\$90,600
		Subtotal				\$277,267
	CENTRAL YARD TOTAL COST					\$783,227

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			Volume (yd ³)	Weight (tons)	Unit Cost	Total Cost
A L L Y A R D S	LNAPL	Interim Remedial Measures	NA	NA	NA	\$550,000
	SWMU 43 - Non-RCRA Cap Construction	Surveying	68,600 ft ²	NA	NA	\$15,100
		Engineering Design, Oversight, and Reporting	NA	NA	NA	\$28,106
		Non-RCRA Cap Installation	68,600 ft ²	NA	\$2.76/ft ²	\$189,300
		Top soil	1,270	NA	\$33.08/yd ³	\$42,012
		Seeding	1.56 acres	NA	\$4,190/acre	\$6,540
		Subtotal				\$281,057
	Hazardous Contaminated Soil and NAPL - CAMU Construction	Mobilization/ Demobilization	NA	NA	NA	\$826,875
		Surveying	100,000 ft ²	NA	NA	\$22,000
		Engineering Design, Oversight, and Reporting	NA	NA	NA	\$735,163
		Installation, Operation and Maintenance of Field Office	NA	NA	NA	\$121,275
		Site Preparation	NA	NA	NA	\$165,375
		Removal of Oily Water and Fire Suppression Systems Utilities	NA	NA	NA	\$55,125
		Composite Liner CAMU Construction	100,000 ft ²	NA	\$19.85/ft ²	\$1,985,000
		Leachate Collection System Installation	NA	NA	NA	\$45,478
		Leachate Treatment System Installation	NA	NA	NA	NA
		Cap Installation	100,000 ft ²	NA	\$2.76/ft ²	\$276,000
		Leachate Treatment System Operation and Maintenance	22,500 gals/day for first 1.5 years, 225 gals/day for next 28.5 years	NA	\$0.09/gal	\$1,319,338
		CAMU Monitoring and Cap Inspection	NA	NA	NA	\$1,800,000
		Subtotal				\$7,351,629
	ALL YARDS TOTAL COST					\$8,182,687
	CMS SELECTED ALTERNATIVE TOTAL COST					\$32,961,212

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			Volume (yd ³)	Weight (tons)	Unit Cost	Total Cost

Notes:

1. NA = Not Applicable
2. SWMU = Solid Waste Management Unit
3. CAMU = Corrective Action Management Unit
4. ISCO = In-Situ Chemical Oxidation
5. MNA = Monitored Natural Attenuation
6. NAPL = Non-Aqueous Phase Liquid
7. 1 yd³ of Soil = 1.5 tons (assuming soil density = 110 lb/ft³)
8. The SWMU 43 hazardous soil volume includes the hazardous soil volumes from SWMUs 5 and 21.
9. Surveying costs are based on a unit cost of \$0.22/ft² with a minimum daily charge of \$1,500. These costs are assumed to be the same for all three scenarios.
10. Engineering design, oversight and reporting costs are estimated to be 10% of the overall treatment costs for each contaminated media.
11. On-site transportation unit costs are \$5.51/ton to transport contaminated media from its point of excavation to the on-site treatment area, and \$11.02/ton to transport contaminated media from its point of excavation to the on-site treatment area and back for recycling as certified clean fill.
12. The volume of stabilized media placed into the CAMU is based on a 10% volumetric expansion factor to account for the volume of the stabilization binders based on the results of the stabilization bench test.
13. The volumes of media estimated for backfill and restoration activities are based on a volumetric expansion fluff factor of 25%.
14. ISCO treatment unit costs are based on average unit costs for full-scale application of ISCO treatment of petroleum contaminated soils given at the 24th Annual International Conference on Soils, Sediments and Water ISCO Workshop on October 20, 2008 in Amherst, MA.
15. MNA costs are based on the existing MNA monitoring schedule for the Perth Amboy refinery, which is as follows: 1) semi-annual monitoring of 30 wells in the Main Yard, 21 in the East Yard, and 3 in the Central Yard; 2) approximately 4 wells are sampled/day/person/monitoring event; and 3) groundwater samples are analyzed for volatile organic compounds (VOCs), alkalinity, nitrate/nitrite, sulfide, sulfate, dissolved iron, and total iron. The duration of MNA monitoring is assumed to be 30 years.
16. Leachate Treatment System Operation and Maintenance costs are calculated on a present value basis with the following assumptions: 1) 22,500 gallons/day of leachate will be collected and treated during the first 1.5 years of CAMU construction, 2) 225 gallons/day of leachate will be collected and treated during the next 28.5 years of operation and maintenance following the completion of CAMU construction, and 3) the unit cost of treating leachate is \$0.09/gallon.
17. CAMU monitoring and cap inspection costs assume an annual cost of \$60,000/year over the first 30 years of operation and maintenance.
18. The volumes of contaminated media = 1.5 times the volumes identified by contouring all available soil data and the most recent groundwater data for the Perth Amboy refinery in the Locus Focus® database using Rockworks® software.
19. For cost estimating purposes, the arsenic soil contamination cap is assumed to consist of asphalt pavement with a 10" subgrade, 9" base, and 1.5" topping, and will be applied in Level D personal protective equipment. The unit cost is from "2005 RS Means Environmental Remediation Cost Data - Assemblies" and adjusted for inflation at a rate of 5%/year.
20. The tailored CAMU will have a low profile with a 16.5 feet high pile and a 3 to 1 horizontal/vertical side slope ratio. The CAMU costs shown are based on an area of 100,000 ft² corresponding to a capacity of 42,800 yd³. This represents half of the maximum CAMU area and capacity available in the planned CAMU location within former tank basins 312, 313, and 318 in the northwest corner of the Main Yard, and three times the area and capacity needed for the anticipated volume of 14,400 yd³ to be disposed in the CAMU.
21. The LNAPL cost is based on the anticipated ongoing operation and maintenance costs for LNAPL removal shown in the Chevron Perth Amboy Refinery 2008 - 2018 Expenditure Plan dated June 2, 2008.